

Spatiotemporal Pattern of Crime Using Geographic Information System (GIS) Approach in Dala L.G.A of Kano State, Nigeria

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Abstract: This study explores the use of Geographic Information Systems (GIS) and spatial database of crime characteristics which helps in the determination of hotspots in Dala LGA of Kano State and also it identifies the challenges facing police departments that seek to implement computerized crime mapping systems. Different data sources were used, data from the Nigerian Police Force (Dala and Jakara Division) of 2008 – 2010. For this study, the crime was divided into four categories: offence against person, offence against property, offence against authority and offence against local act. The spatiotemporal distributions of the crimes from the three years were analyzed. ArcGIS version 9.3 was used for the analysis and results reveal that crime rate is higher outside the city wall while the rate increased from time to time especially in the year 2010. There are more hotspots outside the city wall. It also shows that crime doesn't occur closer to police stations, but seldom occur around outpost police stations. The buffer zones of 2Kms were used and it analyzed that places like Kurna, Gobirawa and YanMata are in need of Police Stations.

Keywords: Crime, GIS, Police station, Spatial, Temporal

I. INTRODUCTION

Crime is a phenomenon which is universal in its varying forms in all cultures and societies, at all stages of organization. The alarming increase in the rate of criminal activities in Nigeria, as reported daily in the local news and media is perhaps a reflection of the nature of every society where goals are used to measure individuals status in society. The Nigerian Police are not equipped with modern automated information system. This is one of the basic problems militating against the effective prevention, detection and control of crime (Rilwani and Eguabor, 2000). Even though, there are so many police stations and their outpost distributed around without enough equipment Musa (2005) explained that Police cannot perform their noble role effectively and efficiently except when provided with adequate funding, equipment, infrastructural facilities, social amenities, and manpower. The level of effectiveness of the police in any country depends mainly on the level of manpower and equipment provided. The level of violent crimes in Nigeria is on the increase looking at the state of the nation.

Yusuf (2010) describe the distribution of Police stations and Manpower in Kano Metropolis which shows Dala LGA had 2 police station, 4 police outpost, 8 senior officers, 123 junior officers with the population of 418,759 (2006 census) and is the least area with senior police officers, even though is the second most populous local government in the Kano Metropolis. He further explained that the distribution of the police station and manpower in Kano Metropolis are uneven. The population ratio of the police according to United Nations should be 1:450 recommended standards (Luivei Times Kenya Sept. 2, 2010). However, Dambazau (2007) explained that there is a general belief that the Nigerian Police has been with a strength of personnel that is far below the capacity required to police the estimated Nigerian population of approximately 120 million, considering the minimum United Nations standard. That is why the study focuses on seeing how GIS would be useful for the Nigerian Police in crime detection, analysis and mapping.

II. GEOGRAPHIC INFORMATION SYSTEM AND THE POLICE FORCE

Today, with the rapid advancement of technology, a computer-based technique for exploring, visualizing, and examining the occurrences of criminal activity is essential. GIS is one of the most influential

tools for facilitating and exploration of the spatial distribution of crime. The fundamental strength of GIS over traditional crime analytical tools and methods is the ability to visualize, analyze and explain the criminal activity in a spatial context. Certain environmental factors, such as the physical layout of the area, proximity to various services and land use are likely to influence criminal behavior and it is necessary to take them into account when analyzing the crime data. Burrough, (1998) described GIS as a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes. Smith *et al* (1987) lamented that GIS is a database system in which most of the data are spatially indexed and upon which a set of procedures operated in order to answer queries about spatial entities in the database. It is a decision support system that involves the integration of spatially referenced data in a problem solving environment. Environmental Systems Research Institute, (ESRI) California (1990), defined GIS as an organized collection of computer hardware, software and personnel to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information. Consequently, modern GIS software allows law enforcement agencies to produce more versatile electronic maps by combining their crime databases of reported crime locations with digitized maps of the target areas (Sahu and Peeyush2011).

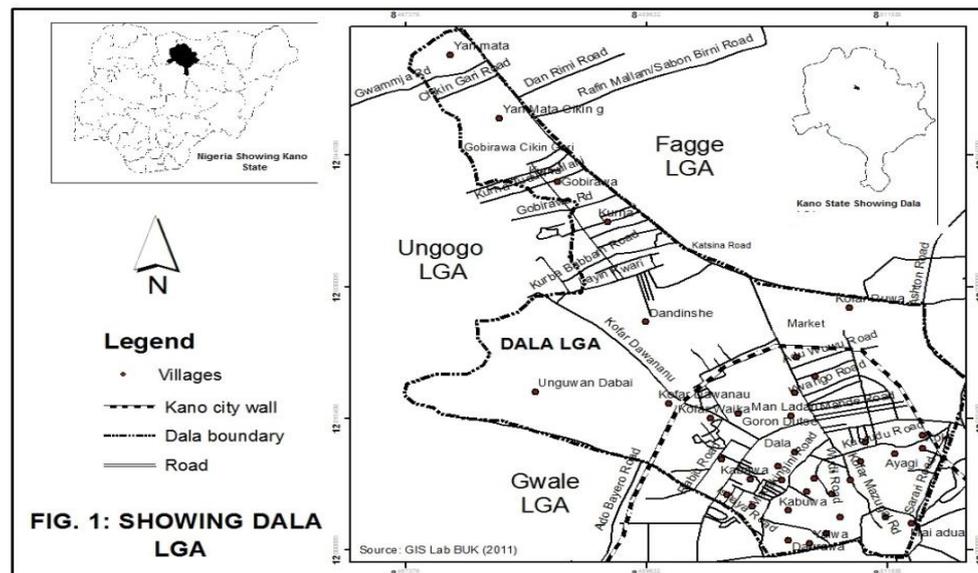
Crime mapping is used by analyst in law enforcement agencies to map, visualize, and analyze crime incident patterns. In addition it enabled them to identify crime hot spots along with other trends and patterns (Soneye, 2002). It was established that a large proportion of the men of the Nigerian Police Force hardly ascertain the areas under the jurisdiction of their stations or define the shortest route from their stations to specific crime areas. As discovered by Soneye, the police stations in Ikeja Local Government Area, Lagos State are far from being distributed according to geographical spread, population characteristics or crime incidences (*ibid*).

Among its wider applications, GIS is used to support operations; aid in command and control decisions; assist in crime and other investigations; complement community problem oriented policing activities; target crime prevention programs; conduct cross-jurisdictional analysis and enhance collaboration with courts and corrections (Source). The ability to map locations of events by their characteristics is an invaluable tool for police officers. Access to this tool is one of the biggest decisions that police departments face when implementing a GIS. Even though desktop mapping programs have become relatively user friendly, none are simple enough to use without extensive training. GIS is also used to answer the question, Where are the highest concentrations of crimes? Several algorithms are available to calculate the areas of highest density in a point distribution (Elizabeth *et al* 1998). In addition the use of maps by the police using GIS and remotely sensed data allows analysts to identify hot spots, along with other trends and patterns. GIS also allows analysts to overlay other datasets such as census demographics, locations of police station, dispatching to emergencies, banks, filling station, schools etc., to better understand the underlying causes of crime and help law enforcement administrators to devise strategies to deal with the problem.

Potential uses for the technology are limited only by the imaginations of individuals in the field. This study will provides an overview of how law enforcement agencies are to use GIS to support a wide variety of activities. This study may contribute to a better management and allocation of police resources, once the occurrences and their associated patterns have been located. The identification of relations between certain types of crime and it distributions may help in the combating and prevention. (This study focuses on the three years data (2008, 2009 and 2010) data collected from the two Police Units at Dala and Jakara Division). The aim of this study is to show the usefulness of GIS technology in crime pattern analysis in Dala LGA of Kano State. The objectives in specific terms are to explain the spatiotemporal pattern of crimes from 2008 – 2010 and to analyze how accessible the police stations are in the area.

III. STUDY AREA

Dala LGA (Figure 1) is among the eight (8) Metropolitan local government areas of Kano state. Is located at latitude $12^{\circ} 00' 00''$ N to $12^{\circ} 03' 21''$ N and longitude $8^{\circ} 27' 30''$ E to $8^{\circ} 31' 40''$ E. Its population was 418,759 (NPC 2006) with total land area of about 1481 Km². It is bounded by in west by Ungogo in the southwest by Gwale, southeast by Municipal, Nassarawa by the east and Fagge by the north.



IV. MATERIAL AND METHODS

Data Acquisition

Crime mapping refers to the process of conducting spatial analysis within the range of activities of crime analysis (Boba, 2005). Relevant administrative records from Nigerian Police Force Dala and Jakara Divisions of Dala local government, supplementary and attribute data were collected through field work interactive use of Global Positioning System (GPS) which provided the co-ordinates of all the police stations in the area. Data were sourced from documentary sources including textbooks, journals, newspapers, magazines and field survey which involve personal interviews and also the map of Kano Metropolis produced by Ministry of Land and Survey Kano State 1978 and a Street guide map produced by ministry of lands and physical planning Kano State 2008.

Spatial, Attribute and Geo-referencing Data

The study was based on spatial database creation and analysis in a computer based GIS environment. The data were created in an excel file (window 2007) in the form of text and later imported and transformed in to a shape file in the GIS environment, during geo-referencing, certain identified abnormalities such as projection and symbolization errors, which are quite common of such convectional maps were rectified before adopted for the study. ArcGIS 9.3 was used for the mapping and the analysis.

Mapping Method

Mapping method for visualizing the spatial distribution of crime based on the boundaries of neighborhood was interpolated. There are three methods for interpolation; Inverse Distance Weighted (IDW), Spline, Kriging. All of them were performed for neighborhoods, but the best result was obtained from Inverse Distance Weighted method

V. RESULT AND DISCUSSION

The criterion for categorization of crimes in this study was based on the Nigerian Police Abstract of Statistics (NPACS). Dambazau (1997) offences are categorized into four main categories: *Offences against person*: These includes Murder, Attempted murder, Manslaughter, Suicide, graviorous harm / Wounding, assault, Child stealing, Slave dealing, Rape / Indecent assault, kidnapping, Unnatural offences, Other offences. *Offences against property*: Armed robbery, Demand with menace, Thief/Stealing, Burglary, House Breaking, Store breaking, False Pretence/Cheating, Receiving Stolen Property, Unlawful Possession (Drugs/Guns), Arson, Other offences. *Offences against lawful authority*: Forgery of currency notes, Coining offences, Gambling, Breach of Peace, Perjury, Bribery and Corruption, Escape from Custody, Other offences. *Offences against local act*: Traffic offences, Township offences, Liquor offences, Dog act, Firearms Act, Narcotics, Other Offences.

Temporal Distribution of Crime

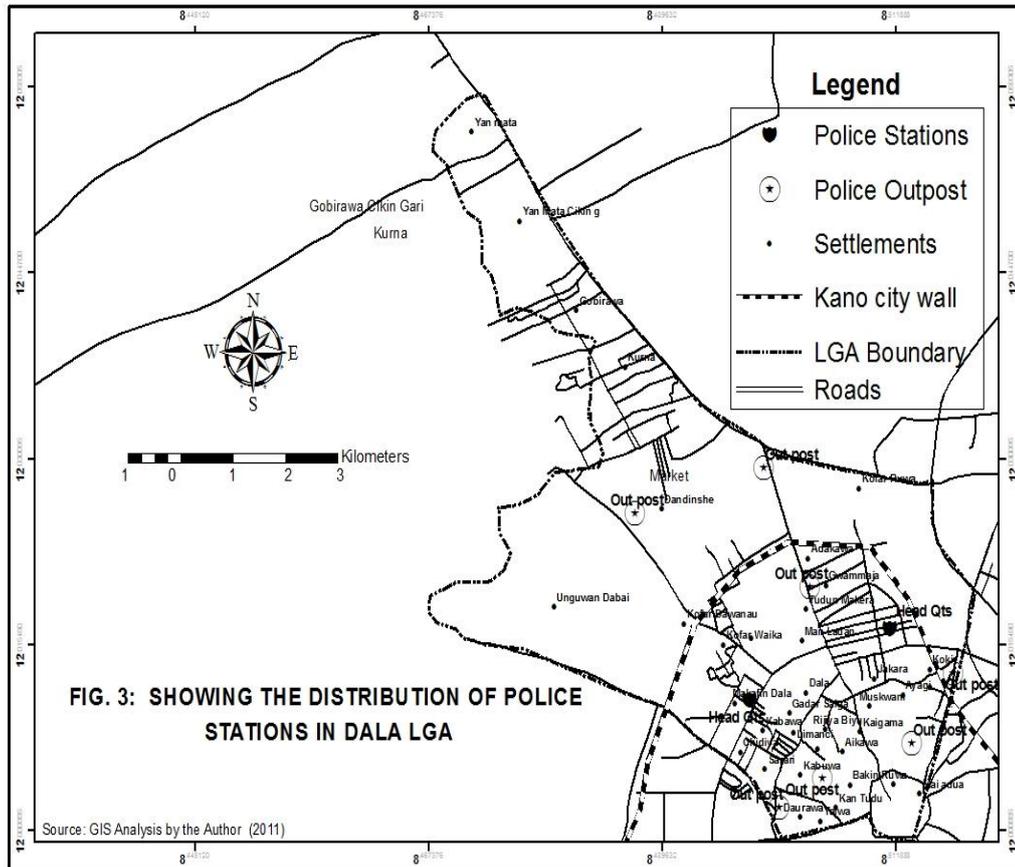
Figure 2 shows the analysis of the crime record collected from the Police units of Dala and Jakara Divisions for the years 2008 – 2010. In the year 2008 offence against local act having the highest crimes recorded with 23 and about 28% of the total crimes recorded, this has to do with the town ship offences and other drug activities especially the youths that venture into the selling and buying of the *Indian hemp*. However, crime against property having the total record of 18 about 29.5% of the total crime, this included the robberies that took place in area around Dandinshe and others are shop breaking and theft. Offence against person was having the record of 17 and taking about 27.9% of the total record and this has to do with some of these crimes like indecent assault, wounding and even the grievous harm or injury which are the most common crime in the area. Offences against authority were having the least record of 3 only in that year of about 5% of the total record, this means that less record of crime that is related to traffic offence, corruption, forgery and others were observed during this year but there is one record of somebody trying to escape from prison (Custody).

FIG. 2: SHOWING THE TEMPORAL DISTRIBUTION OF CRIME IN DALA LGA

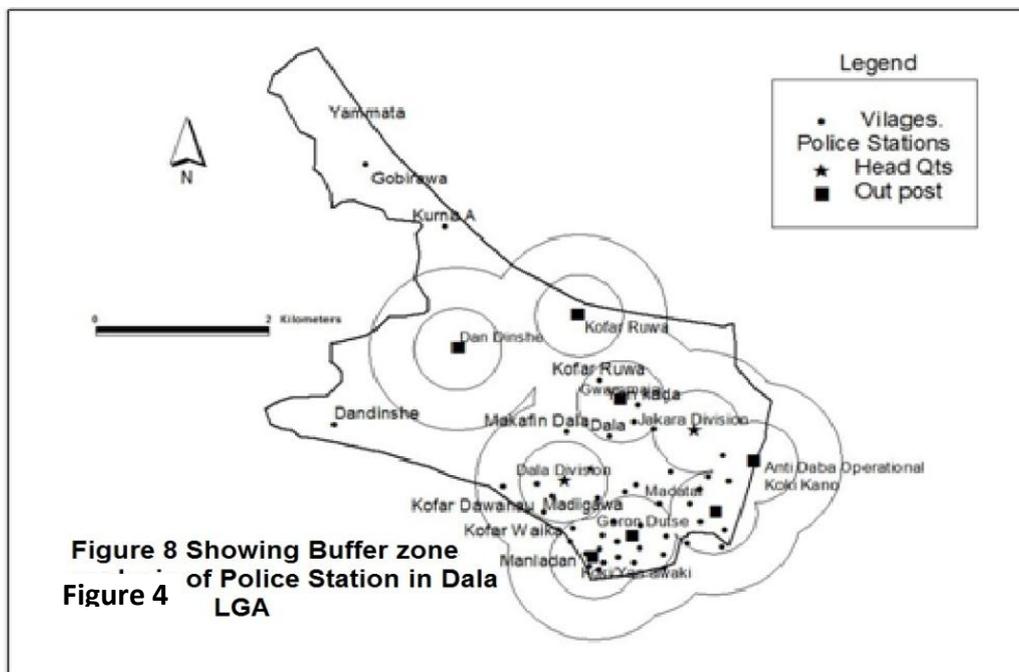
In the year 2009, offences against person recorded of 27 and about 42.2% of the total crime at that year which is the highest and this has to do with gravious harm, wounding and unnertural offence are most common among them, followed by offences against property with 17 in the record and about 26.6% of the total crime recorded and this has to do with stealing, house breaking and receiving stolling property. Also offences against local act have record of 17 which is 26.6% of the total recorded cases in the year, and these was attached with cases that involved township offences and the use of *Indian hemp* by the youth in the area. The least one was the offences against authority with record of 3 cases which takes 4.7% of the total crime recorded. This shows that less record was observed on the crime that is related to curruption and bribery because many can confess involvement and is a crime that is very difficult to establish some facts agaist committers. In the year 2010, the highest recorded cases of crime that were related to offences against property was 40 and with 37% of the total record and this was attached to some cases that has to do with car theft, cheating, house and shop breaking. Also cases with the total record of 34 is offences against person with 31.5% some of these cases were insult, gravoious hurt and unnertural offences. Offences against local act was having 27 and about 25% of the total record in the year and this has to do with local crimes and mostly by the youths of the area, some of these cases were the use of narcotics and township offenses.

Distribution of Police Station

Figure 3 show that the area has a total number of nine (9) police stations. Among which the city wall (*cikingari*)hasseven (7) police stations and two are Divisions (Jakara and Dala), while the remaining four (4) are outpost stations and the remaining two are outpost sited outside the city wall (Dandinshe and KofarRuwa station). According to Yusuf (2010) the total population of police personnel in Dala LGA shows 152 and these should take the population of more than 418,759 persons (census 2006). Table 2 shows that Madatai, Gwammaja, Koki, Dandinshe, KofarRuwa, Yan Awaki and GoronDutse all have the police outpost, while Dala and Jakara are the Head Quarters.



The buffer zone analysis, (Fig. 4) showing the first radius with 1000 meters (1Km) while the second having 2000m. The distance of 2000 meters (2Km) radius has been selected for the purpose of this study to analyse the accessibility to a Police stations and it shows that a person has to travel to some certain distance before reaching to a police station or an outpost station. The first circle shows areas of neglect, places like Makafin Dala, Kofar Dawanau. While the second circle of the 2000m show areas around Kurna, Gobirawa, and U/Dabai.



Spatial Distribution of Crime

A crime hotspot is generally defined as an area containing dense clusters of criminal incidents (<http://www.geospatialworld.net>). Identifications of hotspots help public safety institutions to allocate resources for crime prevention activities. This geographical analysis was made based on crime recorded by the Police of Dala and Jakara Unit of crime events of three years (2008, 2009 and 2010).

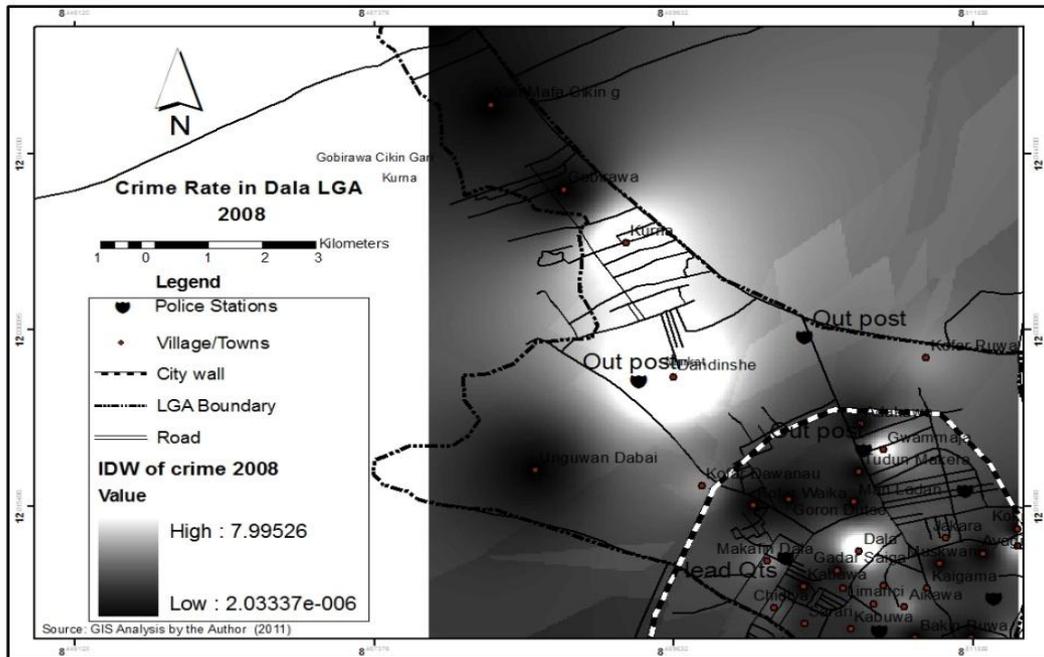


FIG.5: SHOWING THE CRIME HOTSPOTS FOR 2008

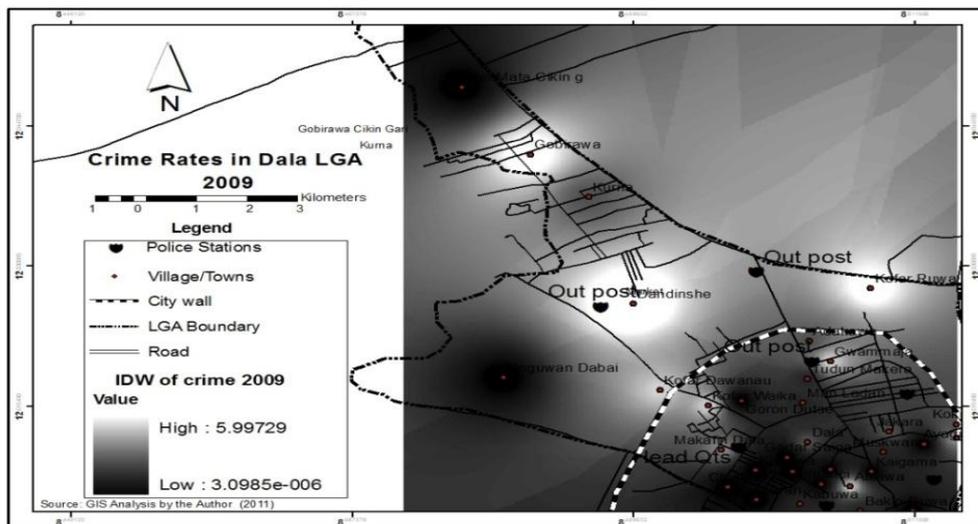


FIG.6: SHOWING THE CRIME HOTSPOTS FOR 2009

Figure 5 analysed the 2008 distribution of crime and hotspots areas, it shows that in the city wall (*cikingari*) have less distribution, but areas around Gwammaja, Dala and some part of Kofar Mazugal and Goro Duste. Other areas outside the city have clustering hotspot, places like Dandinshe and Kurna, while areas around Gobirawa and UnguwanDabai have no record of case. In 2009 figure 6 showing the hotspots within the city, that shows a fair distribution of crime, while places like Jakara, Kofar Dawanau, Makafin-Dala, Gwammaja and some pat of Yalwa are having fewer cases. However, spots outside the city wall were observed, palaces like

Dandinshe, Gobirawa and KofarRuwa and some areas around kofar Dawanau, while U/Dabai areas around Yan Mata have no record of case.

In 2010, figure 7 showing the analysis of the recorded cases reported in this year the rate of crime increased, but this time around it clustered within the city wall (*cikingari*) areas around Dala, Gwammaja, Waika, Dawanau, Bakinruwa and Kofar Mazugal, however it was in this year that the city experienced a tremendous record of cases. Outside the city wall smaller patches of cases were recorded around Dandinshe, Kurna and Gobirawa but Kofar Ruwa was the hottest spot outside the city while U/Dabai and Yan Mata had no record of cases.

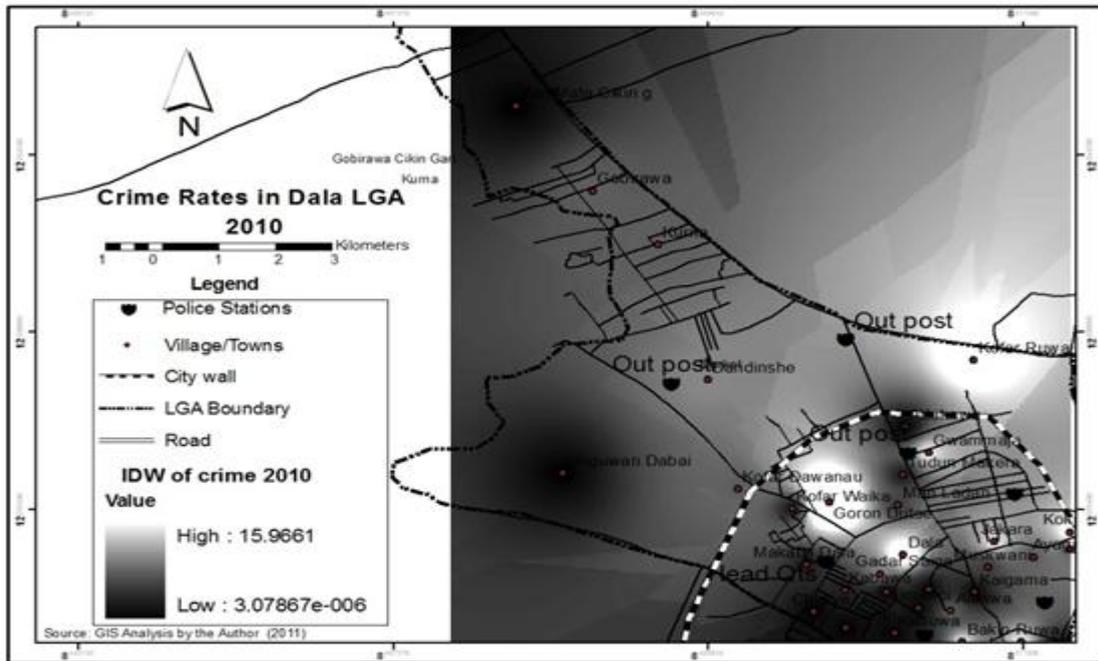


FIG.7: SHOWING THE CRIME HOTSPOTS FOR 2009

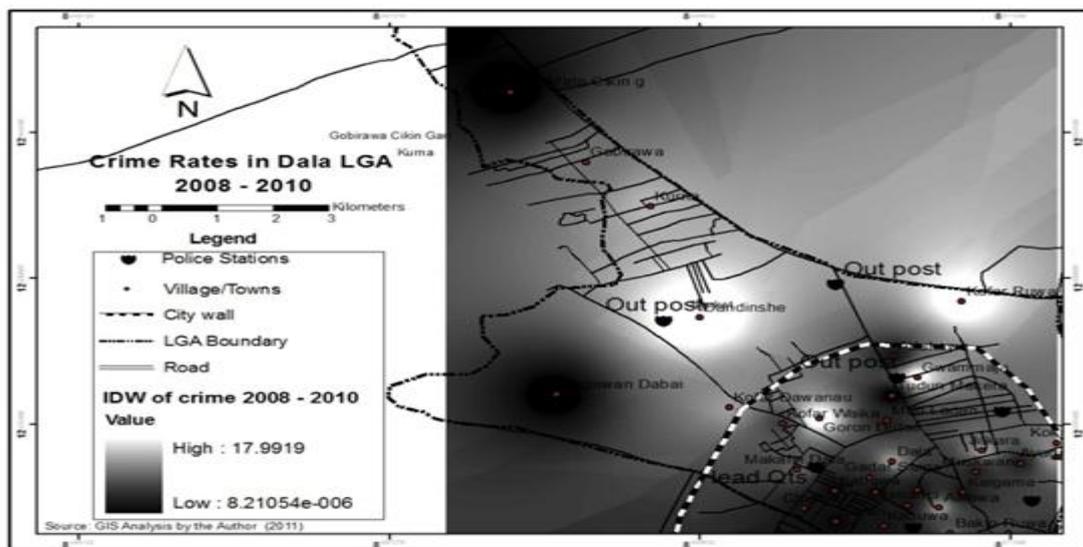


FIG.8 SHOWING THE COMBINATIONS OF CRIME HOTSPOTS FOR 2008, 2009 AND 2010

Figure 8 shows the combinations of the reported cases of 2008, 2009 and 2010 (layers). The hottest spots in the three years are Dandinshe and Kofar Ruwa which all outside the city wall, while in the city wall some patches of spots were experienced to mention few are Kofar Waika and Gwammaja.

VI. CONCLUSION

The findings of this study shows that the spatial pattern of crimes tended to be clustered outside the city wall, areas around Dandinshe, Kofar Ruwa and Kurna, this could be as the result of absence of Police Stations, even though, there are Police outpost but this cannot have enough Manpower and facilities/equipment for policing activities. The study revealed that using GIS is a much more compatible means of crime pattern analysis, because of its geographic referencing capabilities. The three basic categories of GIS functions (database management, spatial analysis and visualization) in a single computer-based system created an environment that is better than the present method of analysis by the law enforcement agencies.

Not only can GIS applications benefit law enforcement agencies in their efforts to analyze crime patterns, but it also has the potential to help the public target high crime areas with preventative measures. Through GIS, communities could be provided with better information on crime in their immediate areas and work with law enforcement officials to determine the best means to reduce the crime rate in their neighborhoods, other public agencies could benefit from GIS in determining the allocation of resources and initiating new programs. Many organizations have a need for an improved system of data manipulation and analysis that can link information to its geographic location, and GIS is an alternative that could aid in this area and result in improvements in the decision-making process.

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